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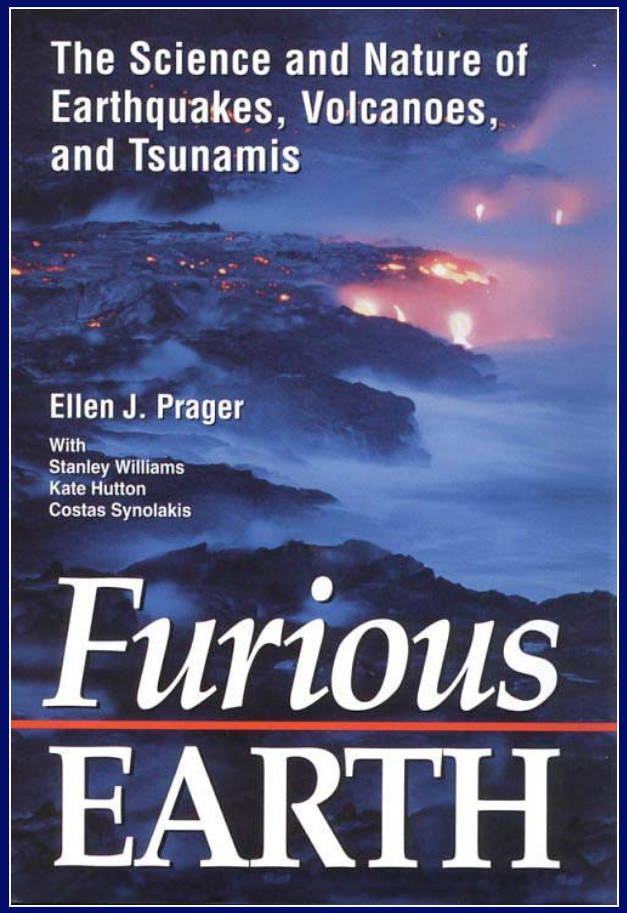

Frequently Asked Questions & 12/2004 Asian Event

Ellen Prager, PhD
StormCenter Communications, Inc.

- *Understanding - Science, Risk, & Probabilities*

- *Preparing - Warnings, Education, Development*

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EARTHQUAKES

Algeria, 1980

Stanford University, 1906

Loma Prieta, 1989

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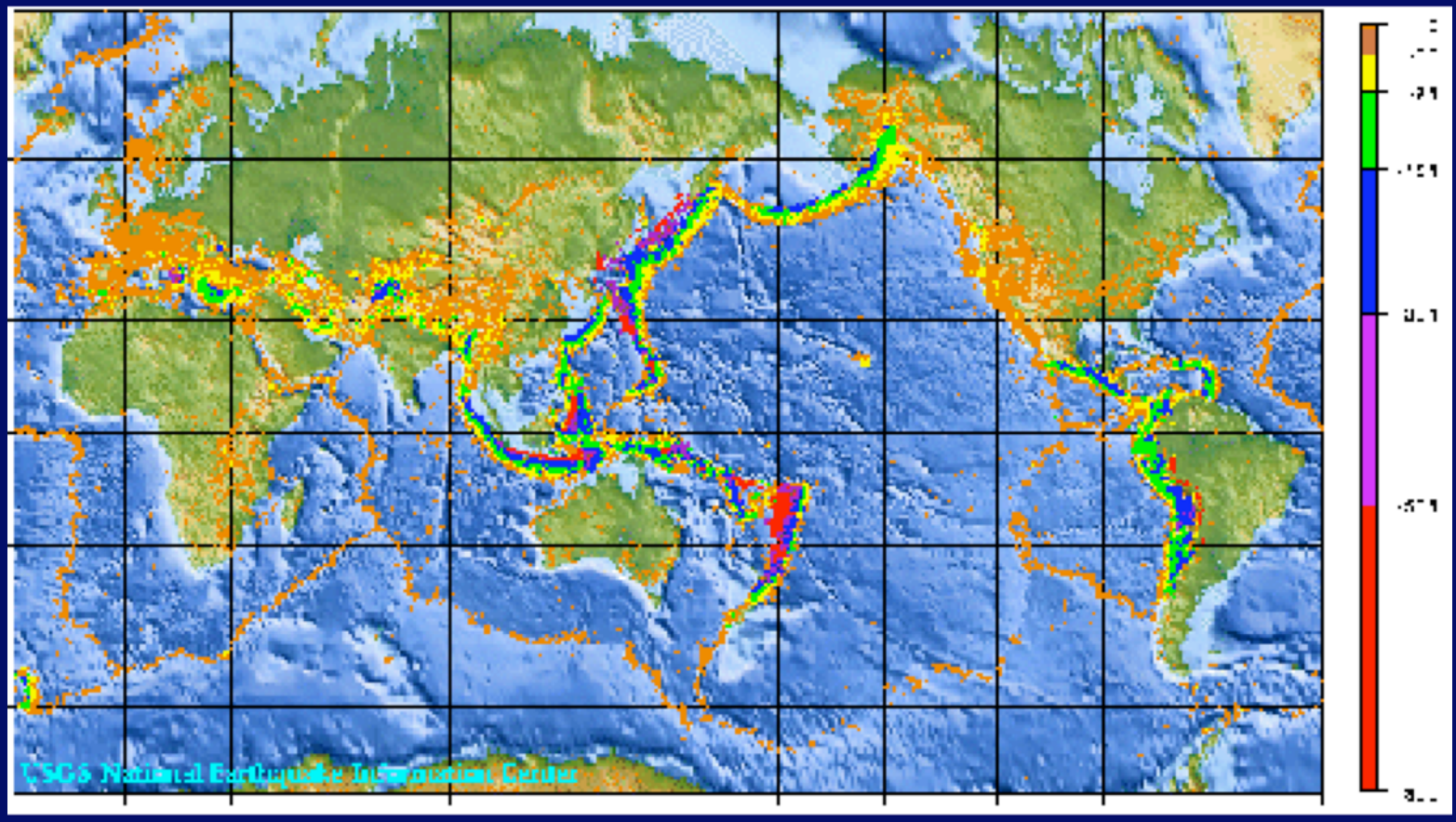
World Seismicity 1975-1995



Worldwide there are 2-3 earthquakes of 6.5 magnitude or greater each week

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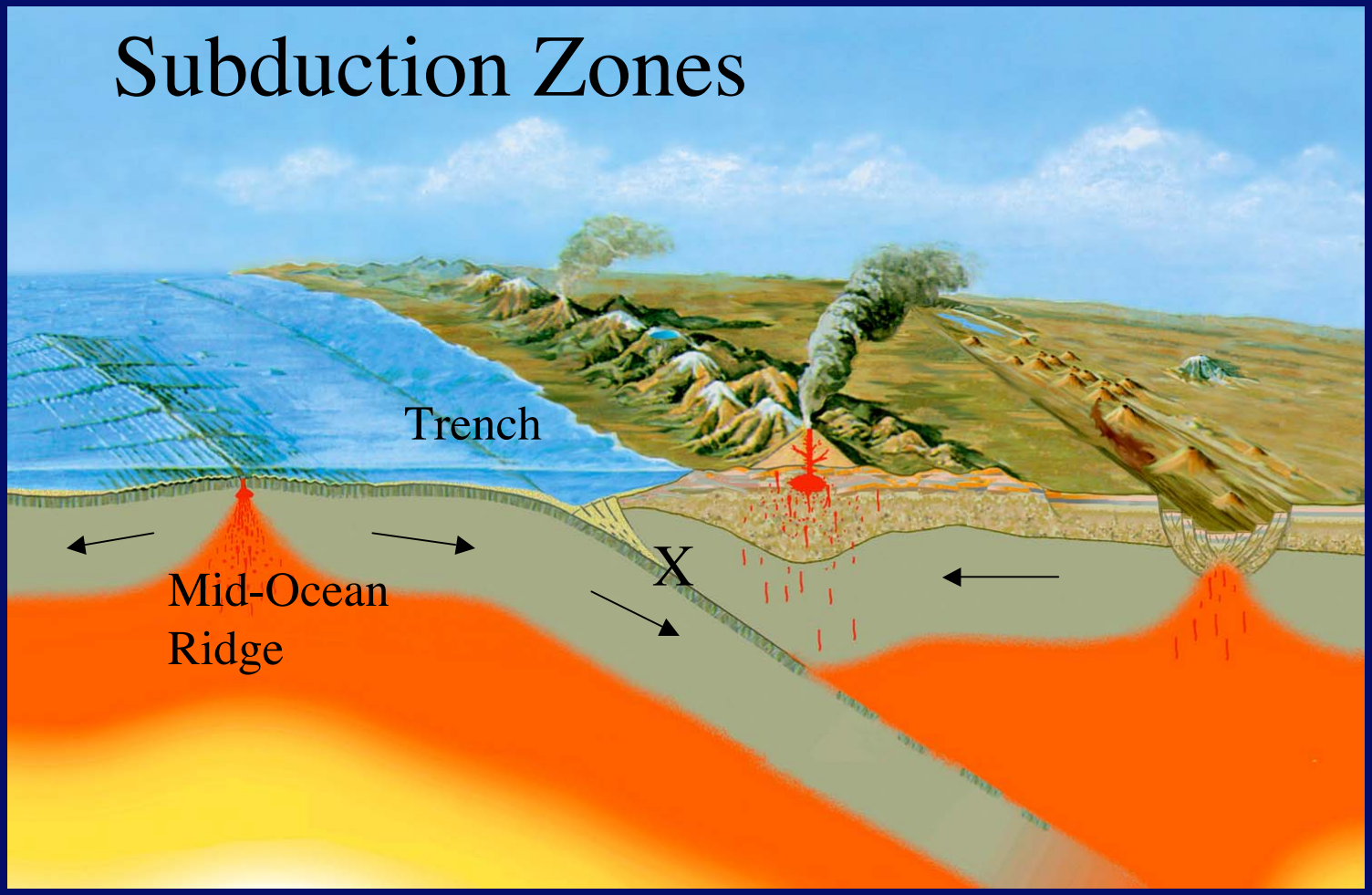
Subduction Zones



After Vigil, This Dynamic Planet

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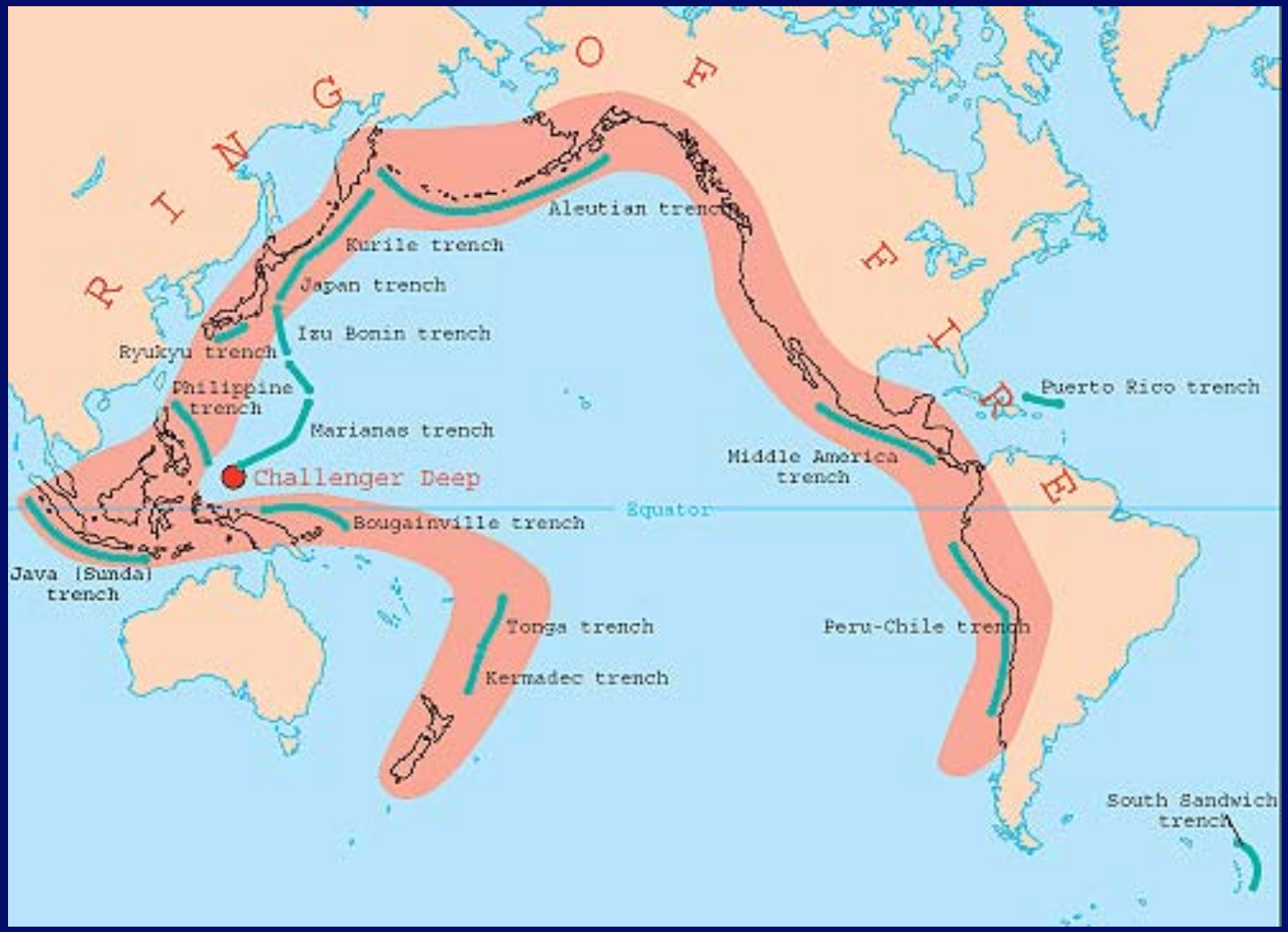

Courtesy USGS

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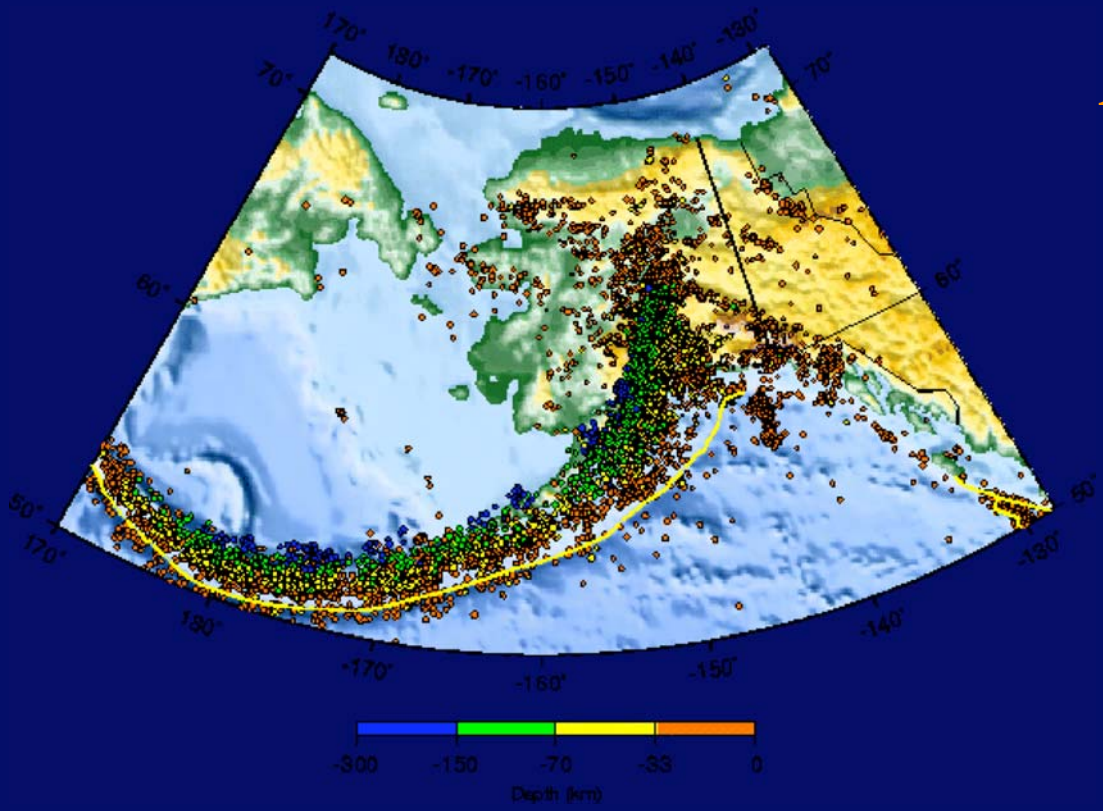
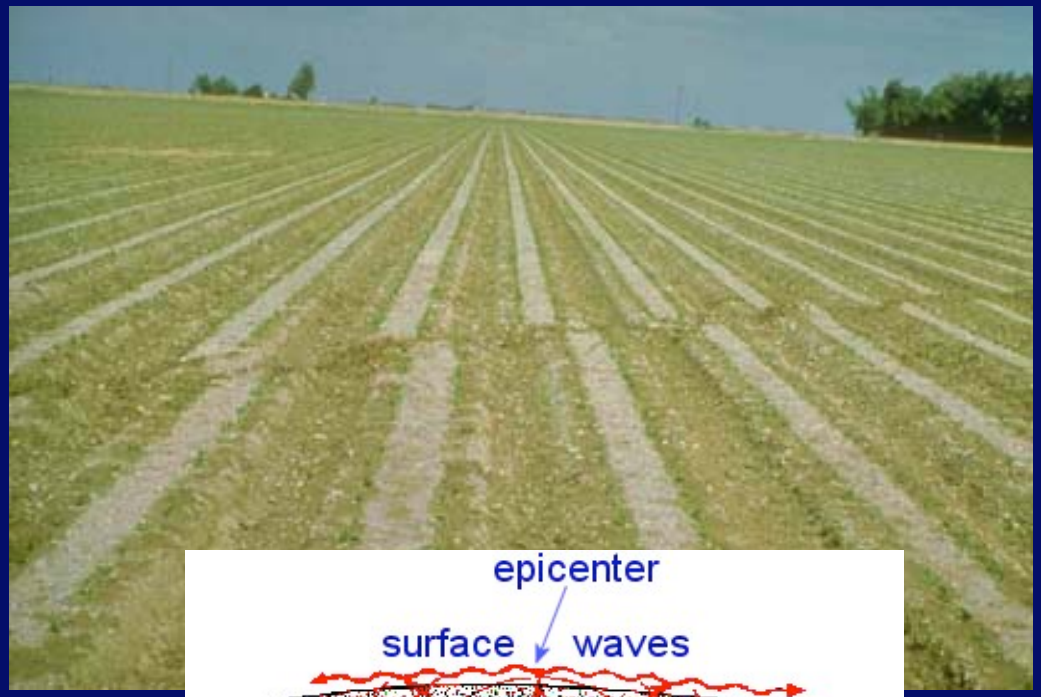
Where in the U.S. do earthquakes most frequently occur?



Alaska !

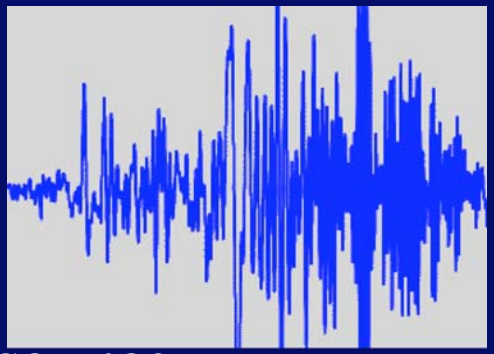
How do earthquakes happen?



<u>Along Fault</u>

- *Slow movement and sticking*
- *Strain builds up*
- *Rupture and deformation*
- *Energy released as vibrations*

Magnitude



- based on average of amplitude seismic waves different stations - geology, direction and distance away from source

- a measure of how much the earth shifts

- logarithmic - each level 10X greater than previous in terms of shaking, 32X in energy

- several different magnitudes now….greater than 6.0 - moment magnitude

What determines the size and impact of a Quake?

Size of the rupture…energy released

Largest quake ever recorded….9.5 - 1960, Chile

1964 Good Friday Quake in Alaska 9.2

Both generated tsunamis

9.0 magnitude or greater

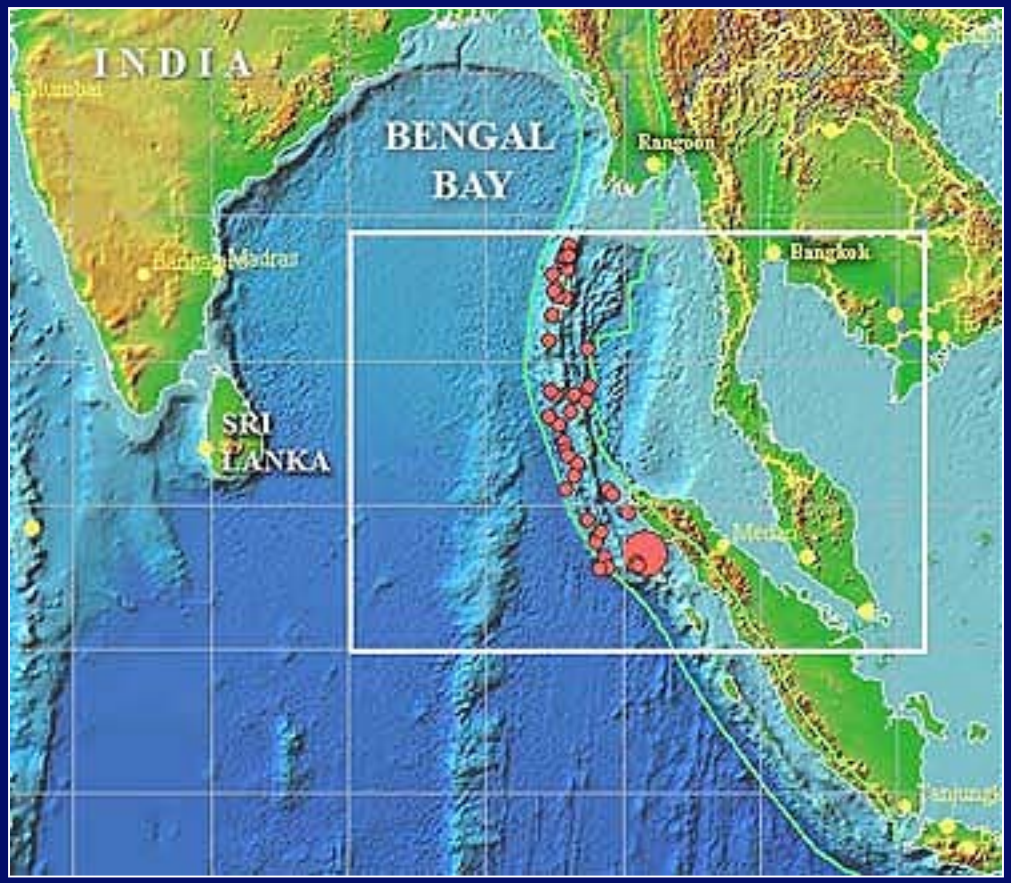
large rupture over large surface area

1,000 km long possible

not only intense, long lasting…4 to 5 minutes

Impact - Population density, type and safety of construction, And geology/nature of the surface and underground

What about Aftershocks…
…..how big & how many ?



- *Larger aftershocks tend to come sooner rather than later*
- *Decrease with time*
- *Can trigger activity on other faults*
- *Tend to outline rupture zone*

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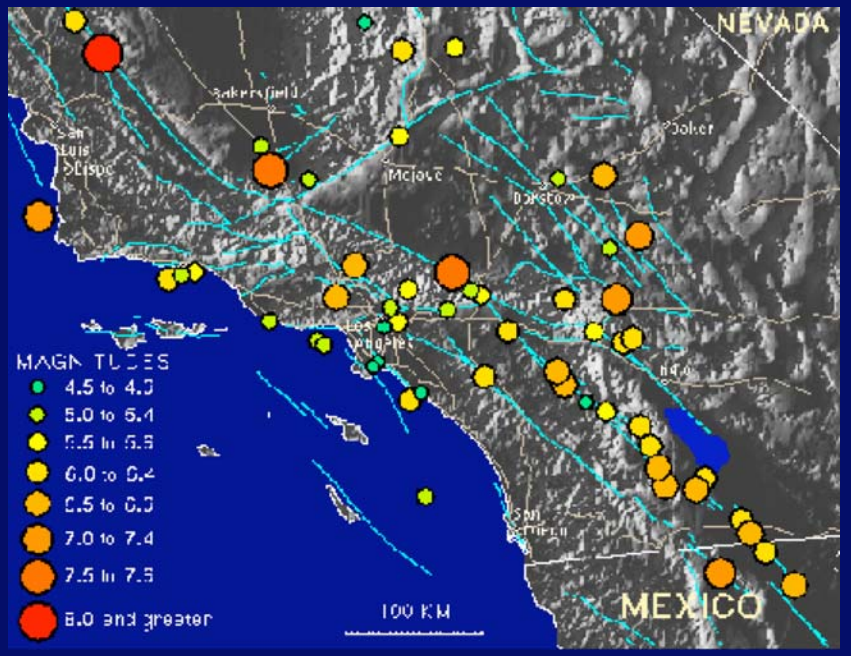
Earthquake Prediction?

Some seismologists believe quakes are inherently unpredictable !

Probability of a quake of a certain magnitude over a given time frame



Southern California, by 2024 some believe that there is an 80 - 90% chance of a 7.0 or greater

Are there reliable quake precursors ?

- *Animals*
- *Groundwater*
- *Magnetic Field*
- *Infrared Signature Satellite Imagery*
- *Foreshocks*

1975 7.3 Haicheng Quake, China
100s of foreshocks, groundwater changes, strange animal behavior - evacuation
1976 7.2 Tangshan Earthquake…> 240,000 killed

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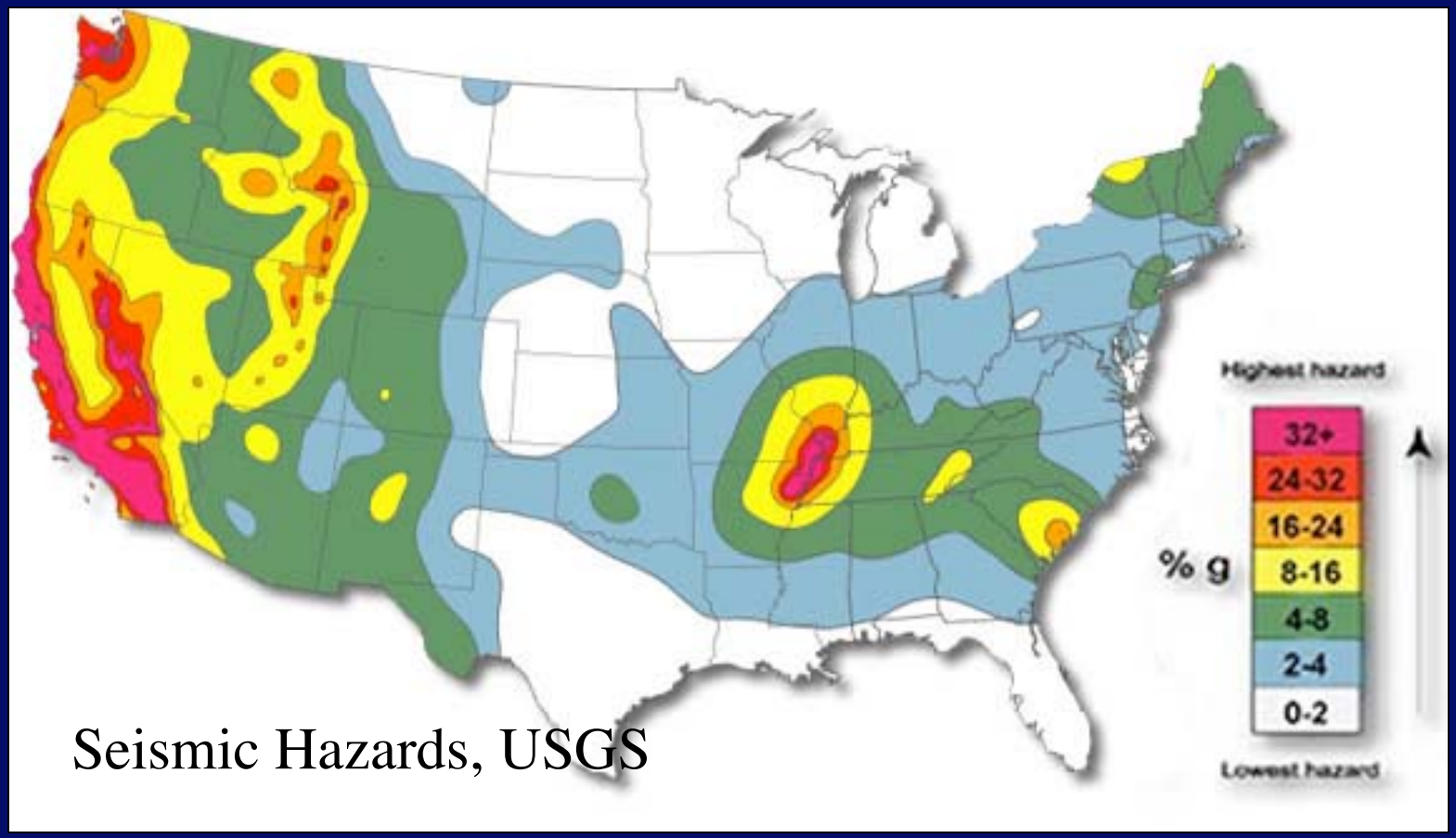
Assessing Risk and Preparing



Seismic Hazards, USGS

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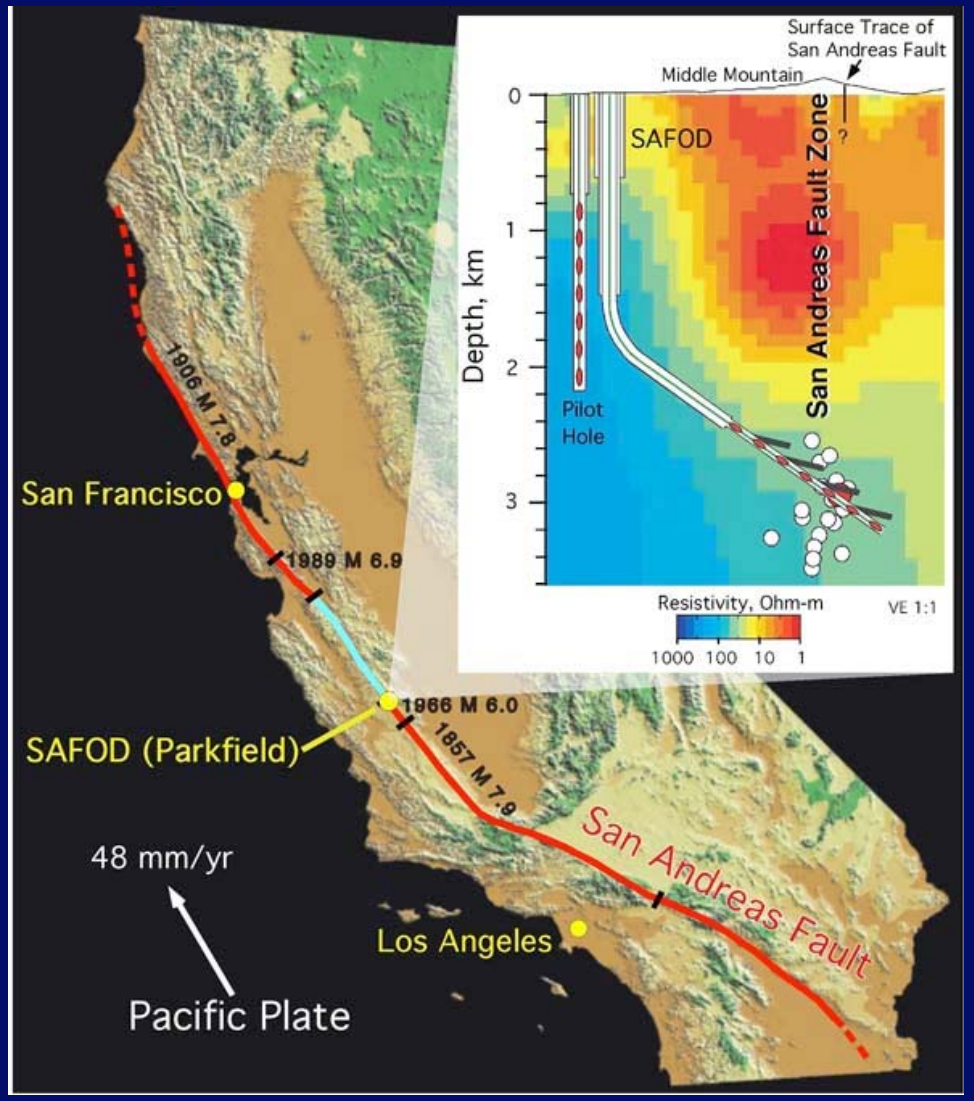
Earthscope

www.earthscope.org

? Warning Systems

- seconds to minutes
- funds diverted from preparedness
- experimental (Japan, Mexico, & Taiwan)



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TSUNAMIS

1992

2004

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Not if, but when -

1992 - Nicaragua, Flores Island
1993 - Okushiri
1994 - East Java
1994 - Mindoro, Kuril Islands
1995 - Manzanillo
1996 - Irian Jaya, Peru
1998 - Papua New Guinea

1992, NGDC/NOAA

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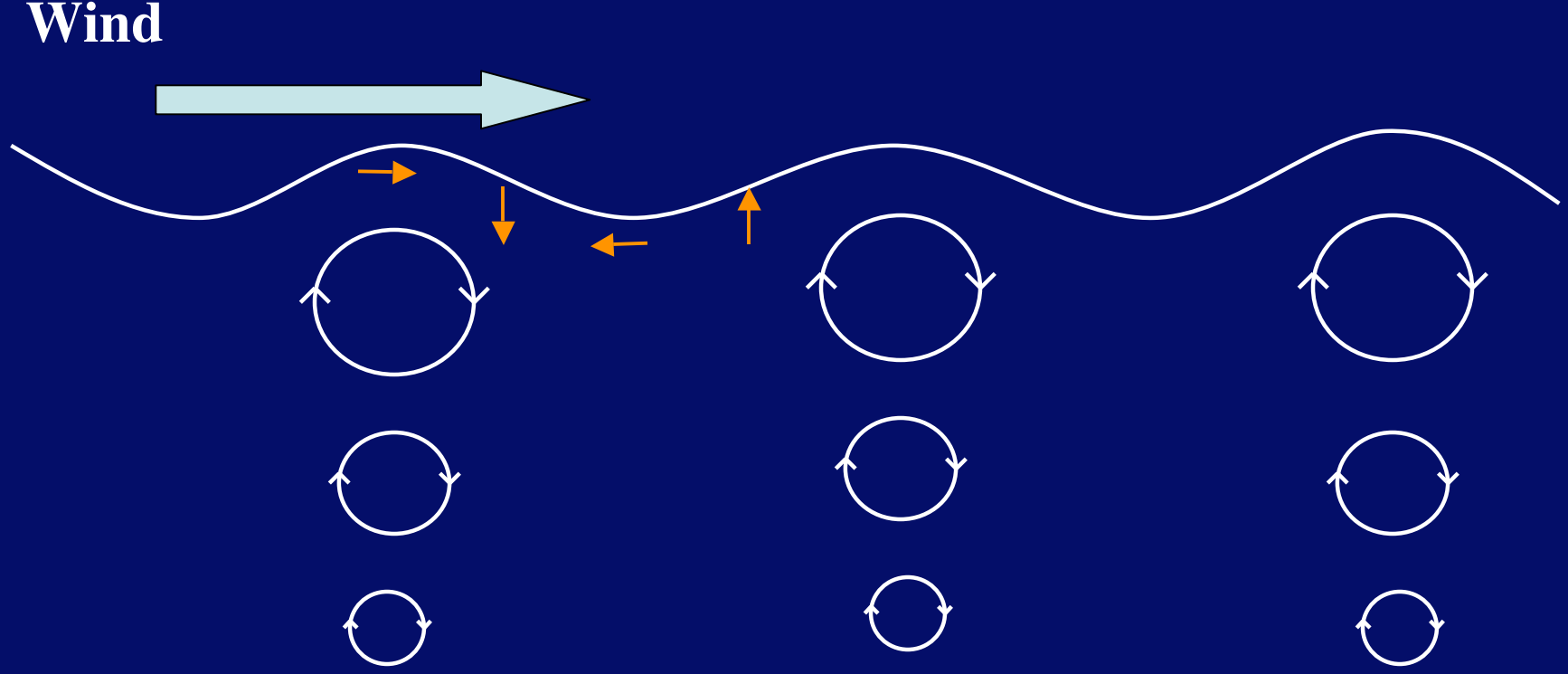
What is a Tsunami ?

Seismic sea wave created by the sudden movement or disturbance of the sea floor - earthquake, volcanic eruption, landslide, or asteroid impact

Many tsunamis may be triggered by quake-induced landslides

Tsunamis (vs. wind-generated waves)



Wavelength - < 100m

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Tsunamis

Wavelength - 100s km

Long, low, fast moving (500 mph)
Entire water column in motion
Amplitude doesn't decrease with depth
Little energy loss as travels
Imperceptible in open ocean

Energy Transfer:

Seafloor → **Water** → **Land**

Approaching Shore - Shoaling or Feeling Bottom

Wave front slows (30 mph over land), steepens as height increases

1958 Lituya Bay, Alaska, landslide generated tsunami 450 m (1500 ft)

Surge or Wave ?

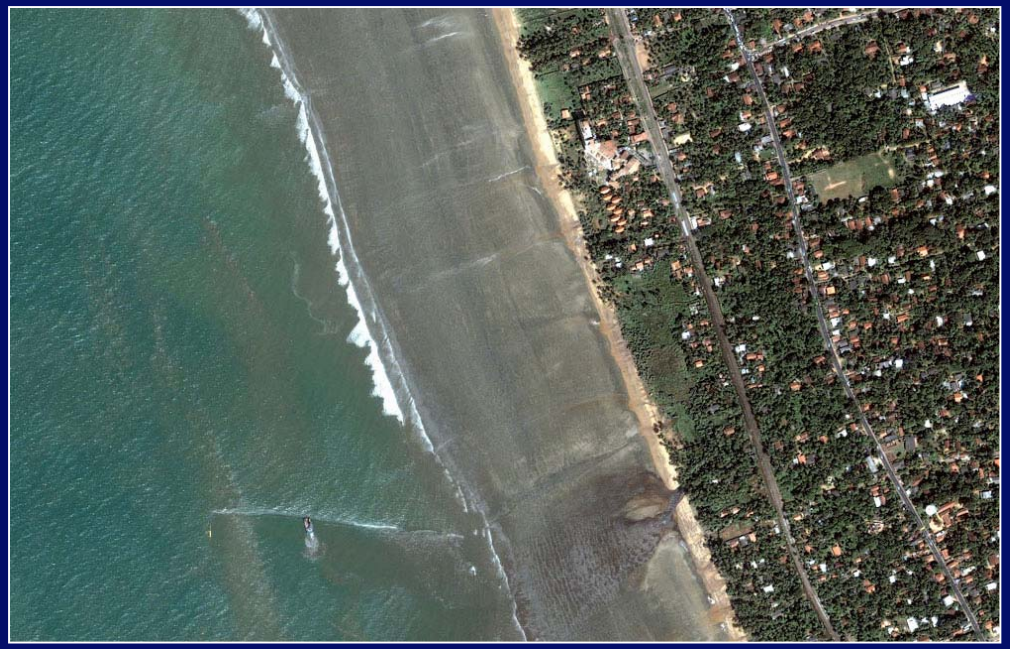
Depends on bathymetry, configuration of coastline, bottom type, direction of approach, and triggering event

Quake triggered - 10m, landslide - ?

HA, 1946

What are the warning signs or precursors ?

- Retreat of the sea - fast, extreme low tide
- Ground shaking
- Loud noise from offshore - bang or rushing freight train



Indonesia 2004, DIGITALGLOBE

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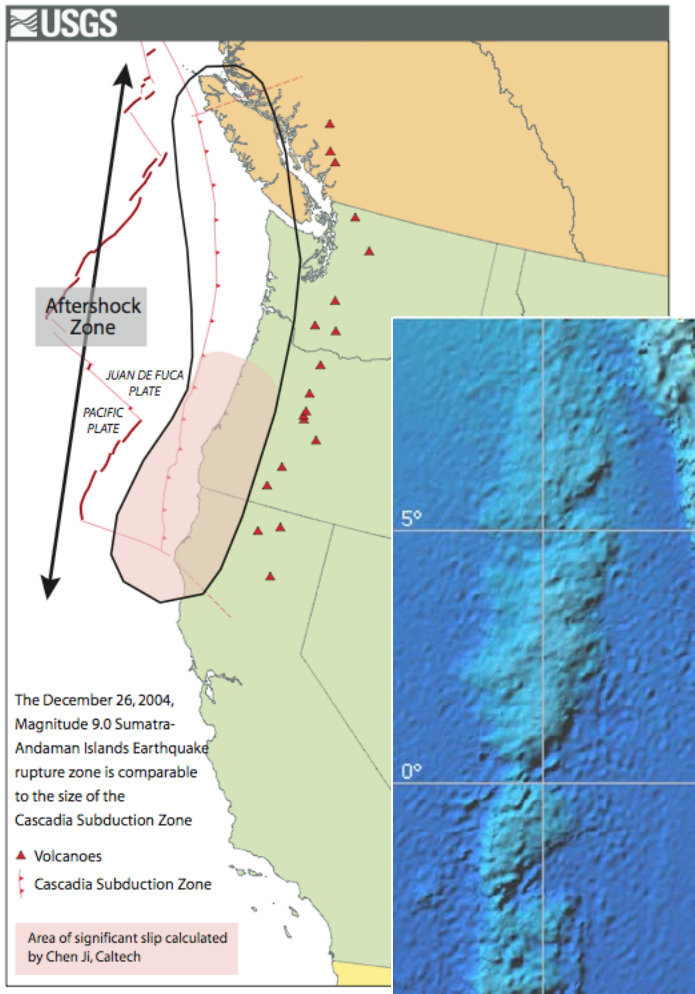
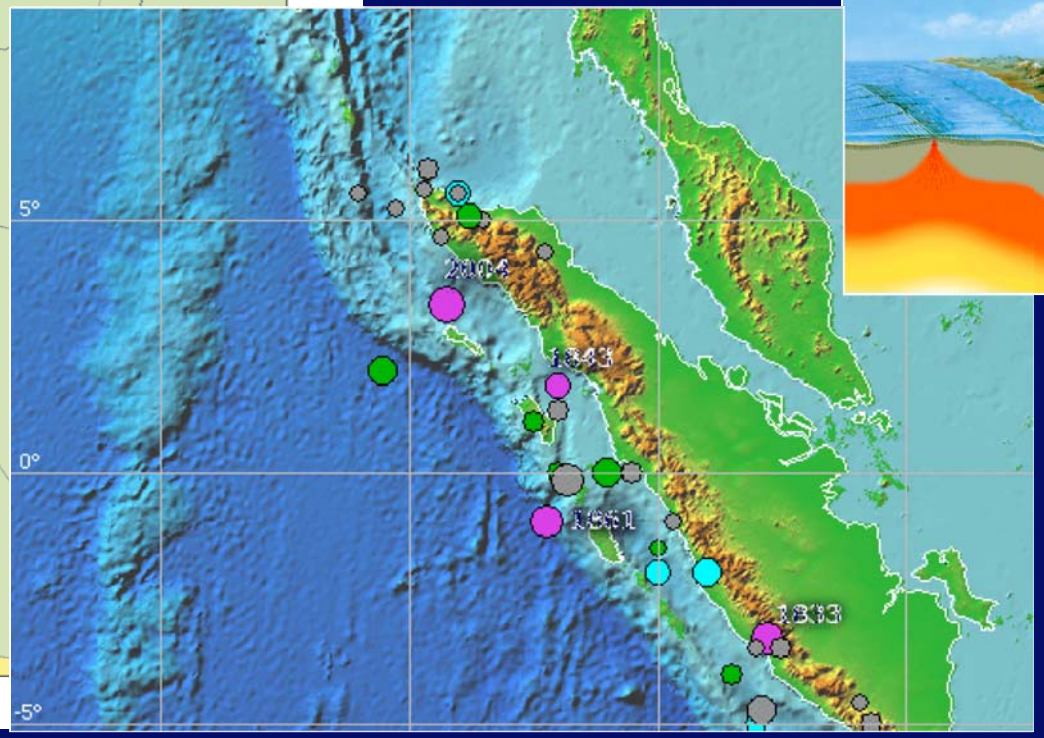
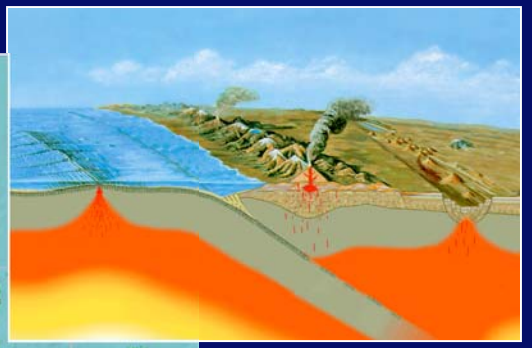
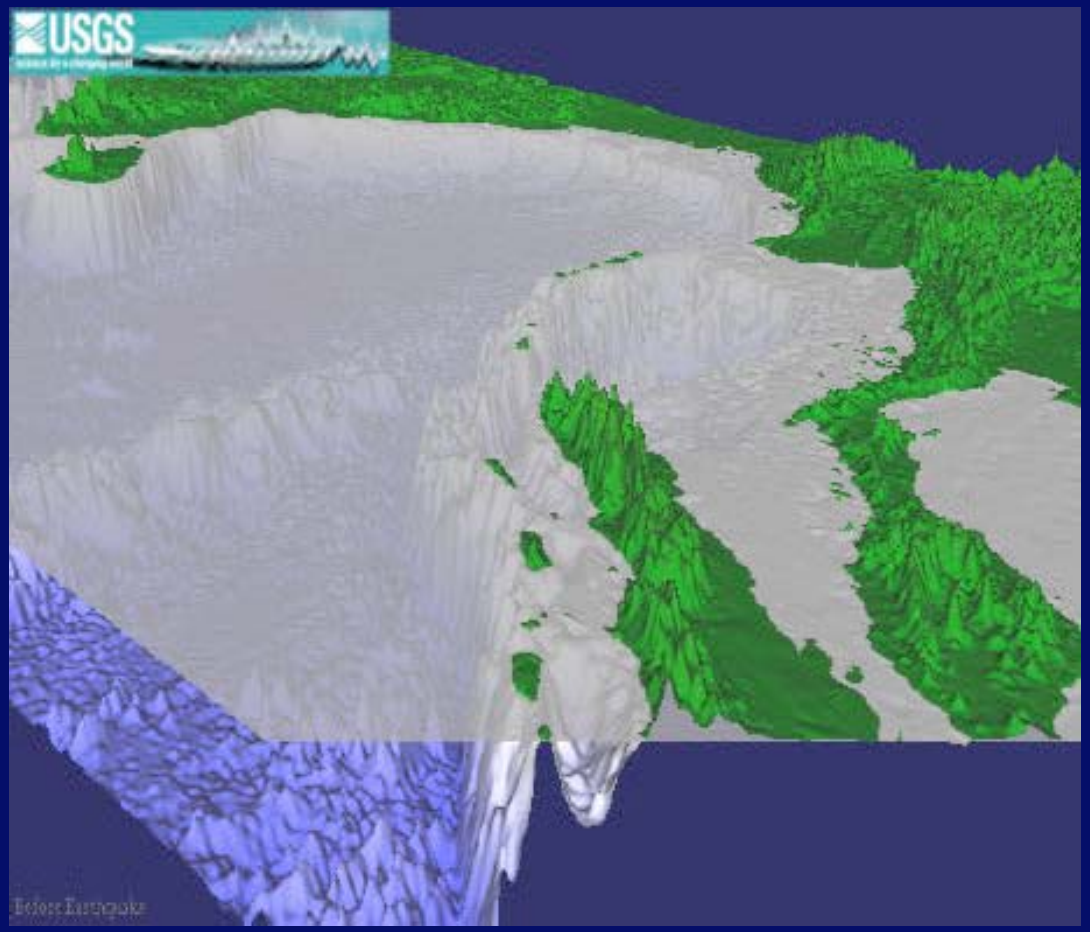
Sumatra December 26, 2004 9.0 magnitude quake









Tsunami Modeling:

Earthquake Model

↓

Wave Model

↓

Flood Model

Courtesy of Geist, USGS

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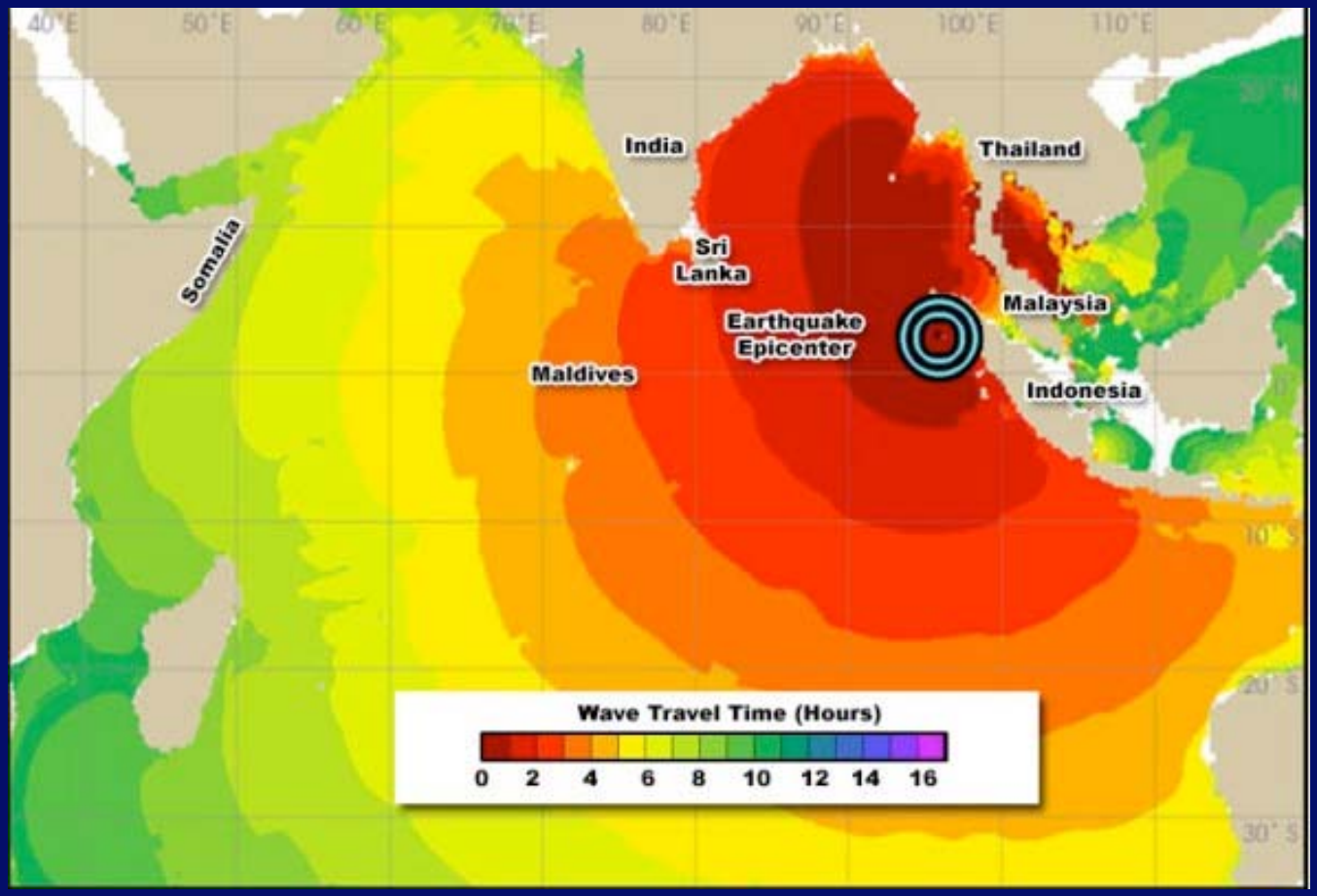
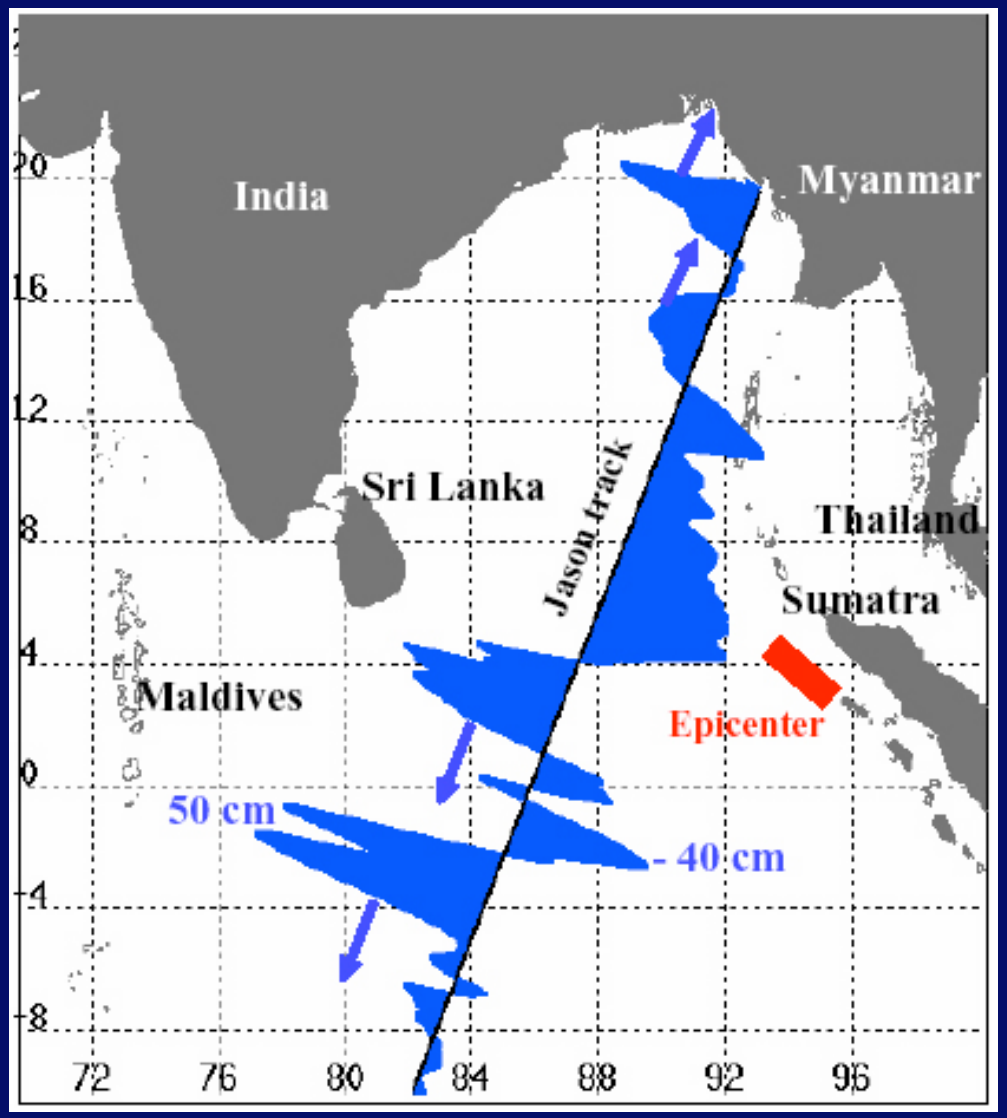
Arrival Time (hours)



Dr. Vasily Titov, NOAA Tsunami Research Program, Pacific Marine *Environmental* Laboratory



Sea Surface Height From Space 12/26/04 US/France Jason

Courtesy of NASA

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BEFORE

AFTER

Banda Aceh, Courtesy of DIGITALGLOBE

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BEFORE

AFTER

Sri Lanka, Courtesy of DIGITALGLOBE

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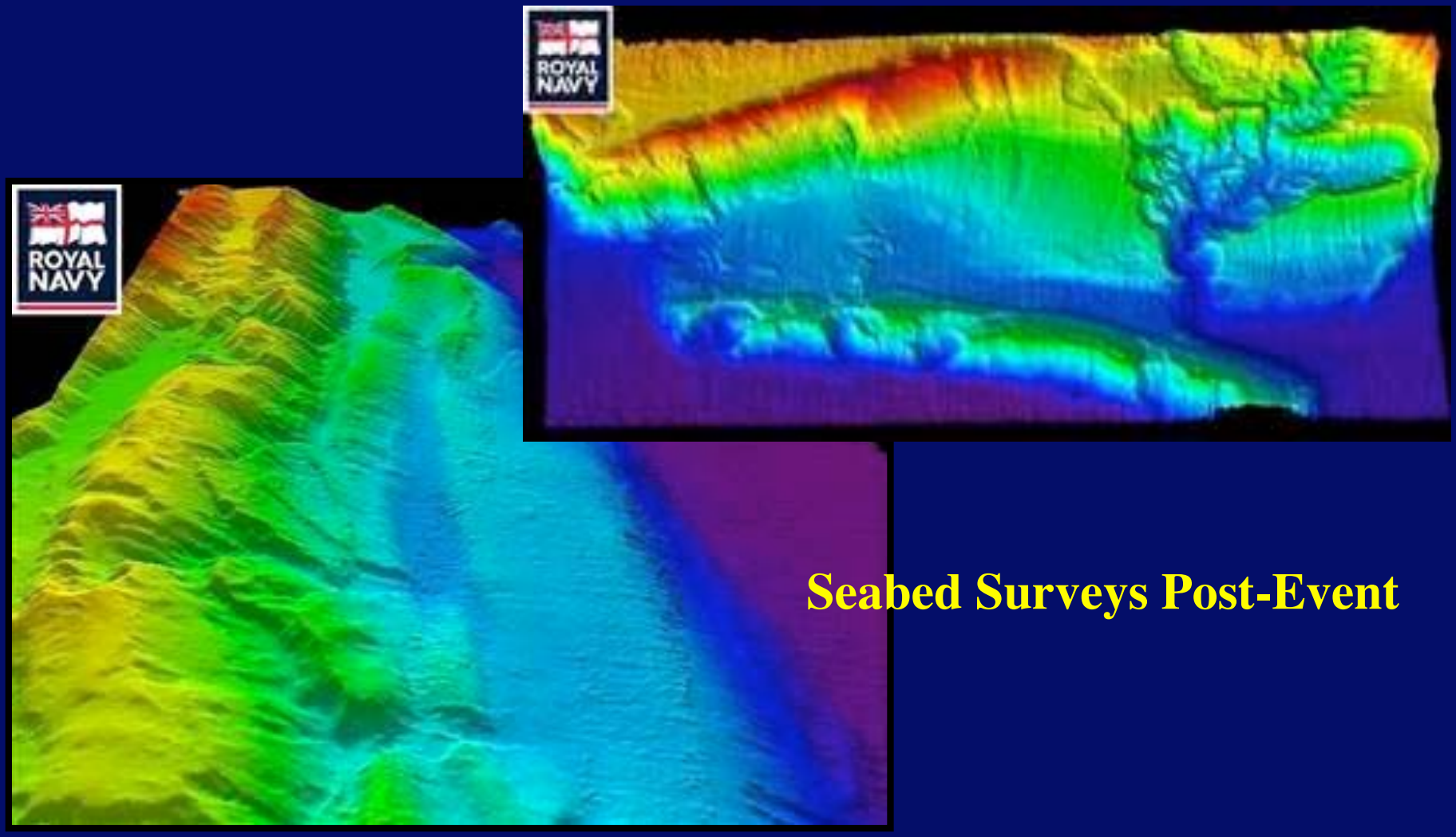

Seabed Surveys Post-Event

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2002 **2005** **< 10 m elevation**

Phuket, Thailand, NASA/JPL

Post-Event Surveys

NW Sumatra

Courtesy USC Tsunami Research Group

Sri Lanka

- ***Vertical Run-Up: < 3 to > 12 m (30 m, V-shaped valley)***
- ***Inundation Distance: 50 m to 1 km***
- ***Tsunami Height: 3 to 10 m***

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Warning Systems?

- Local vs Distant Tsunamis
- Technology - Instrumentation, Centers, Staff
- Communications - Emergency response infrastructure
- Education

  Know the warning signs & responding

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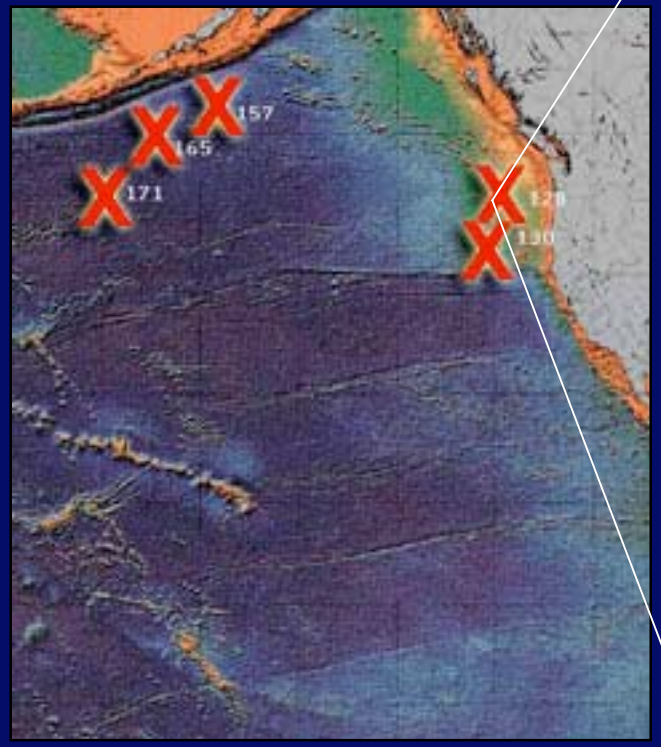
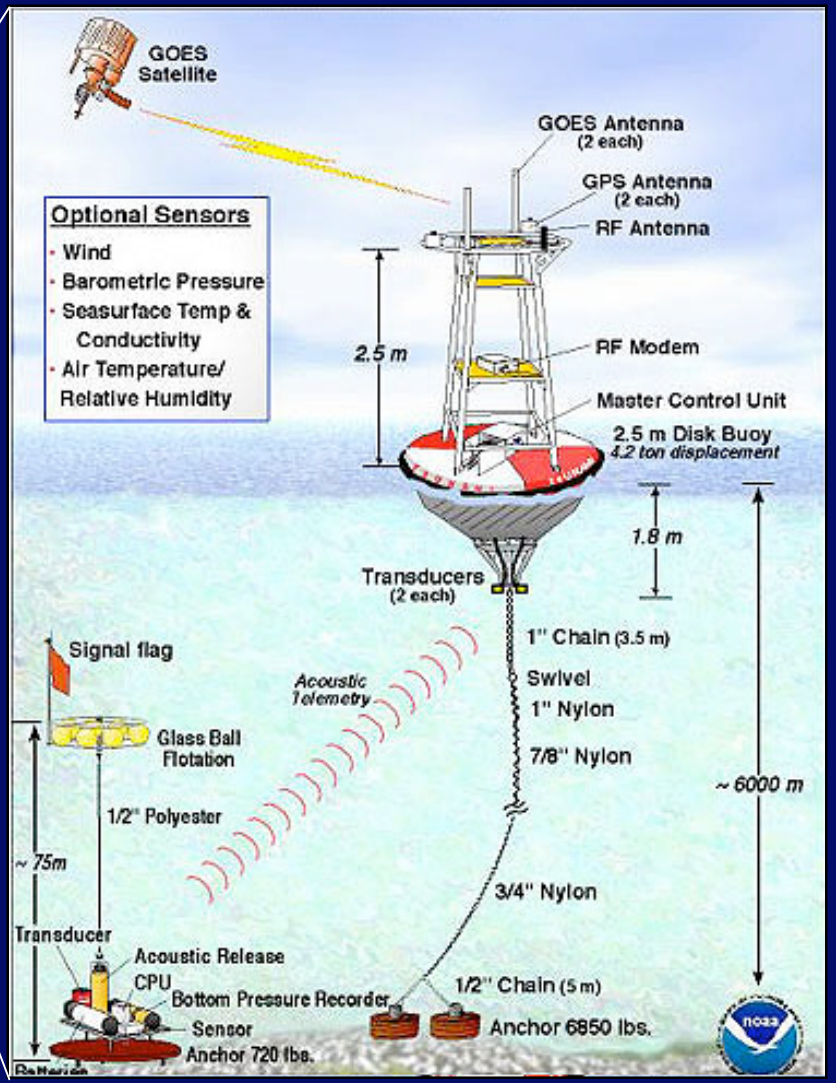
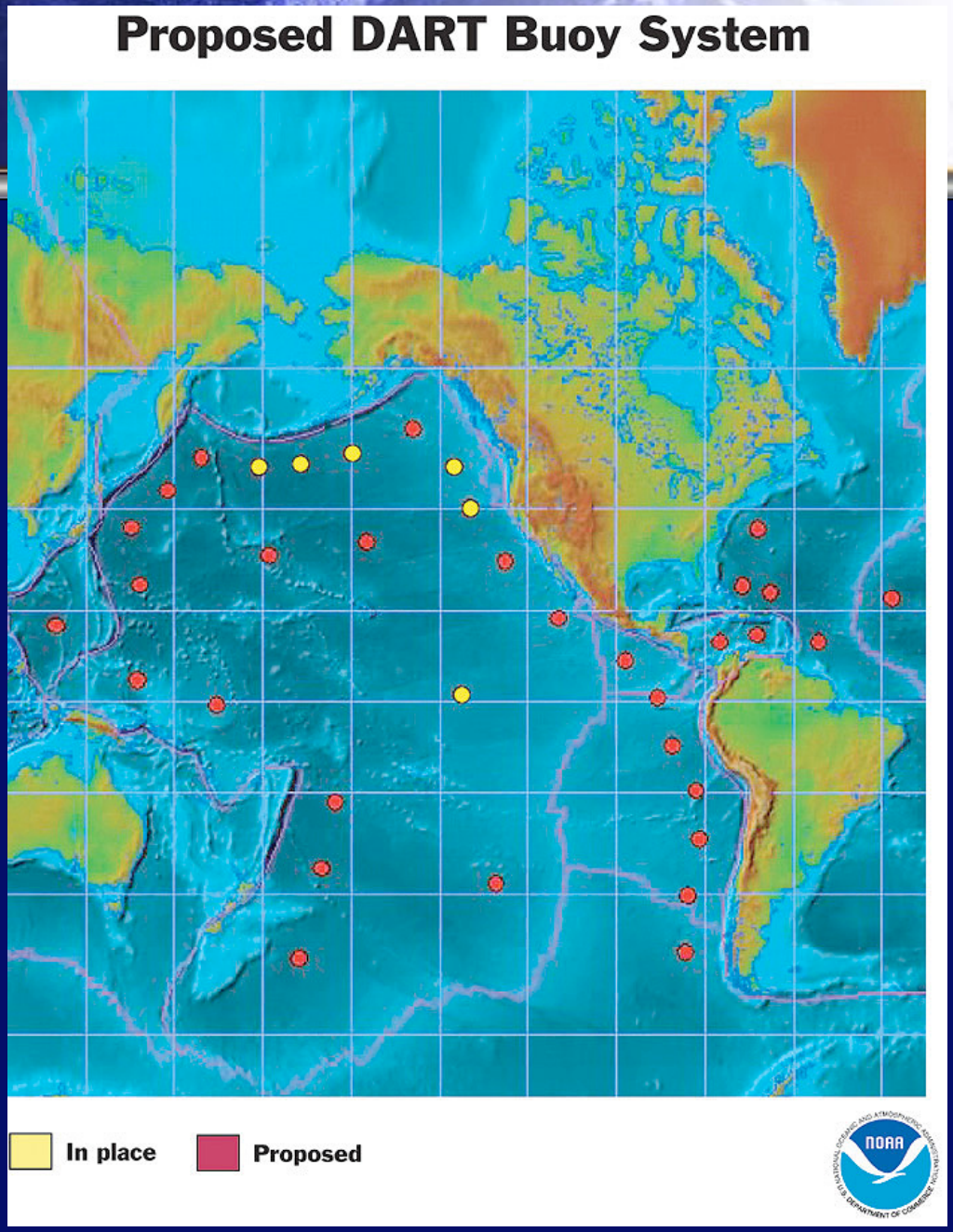
DART Mooring Buoy



Current Investment = $20M

Courtesy NOAA





Investing $37.5 million over 2 years

Expanding seismic network

The Future ?

Alaska, Hawaii
Pacific NW
California
Caribbean

Atlantic Coast
Gulf of Mexico